



First report of armored catfishes Callichthyinae Bonaparte, 1838 (Siluriformes: Callichthyidae) in the subterranean domain of northern and northeastern Brazil

Luiz Fernando Caserta Tencatt,¹ Bruno Ferreira dos Santos,² Maria Elina Bichuette³

1 Universidade Estadual de Maringá, Coleção Ictiológica do Núcleo de Pesquisas em Limnologia, Ictiologia e Aquicultura e Programa de Pós-Graduação em Ecologia de Ambientes Aquáticos Continentais, Av. Colombo, 5790, 87020-900 Maringá, Paraná, Brazil. **2** Universidade Federal de Mato Grosso do Sul, Programa de Pós-Graduação em Biologia Animal, Av. Costa e Silva, 79070-900 Campo Grande, Mato Grosso do Sul, Brazil. **3** Universidade Federal de São Carlos, Departamento de Ecologia e Biologia Evolutiva, Laboratório de Estudos Subterrâneos, Rodovia Washington Luis, km 235, 13565-905 São Carlos, São Paulo, Brazil.

Corresponding author: Luiz Fernando Caserta Tencatt, luiztencatt@hotmail.com

Abstract

The first occurrence of the armored catfishes of the subfamily Callichthyinae is reported in subterranean water bodies of northern and northeastern Brazil. The records include 3 species, each occurring in 1 of the 3 caves in the central and northeastern regions of Brazil: *Callichthys callichthys* from Casa do Caboclo cave, Sergipe state; *Hoplosternum littorale* from the Gruna da Lagoa do Meio, Bahia state; and *Megalechis thoracata*, from Casa de Pedra cave, Tocantins state.

Keywords

Camboatá, cave, hypogean habitat, karstic areas, Neotropical region.

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Introduction

The Callichthyidae Bonaparte, 1838 includes small to medium sized catfishes, which are clearly distinguished from other Siluriformes by the presence of 2 longitudinal series of dermal plates along the flanks (Reis 2003). Currently, the family harbors about 200 valid species grouped into 2 subfamilies, Callichthyinae Bonaparte, 1938, with 5 genera, and Corydoradinae Hoedeman, 1952, with 3 genera (Britto 2003, Reis 1998, 2003, Eschmeyer 2017). Callichthyinae includes the larger members of the family, *Callichthys* Scopoli, 1777, *Dianema* Cope, 1871, *Hoplosternum* Gill, 1858, *Leptoplosternum* Reis, 1997 and

Megalechis Reis, 1997, which can be diagnosed from the Corydoradinae by the presence of the following features: (i) dorsal face of lateral ethmoid bearing a segment of the supraorbital latero-sensory canal, (ii) preopercle covered by skin, (iii) dentary with teeth, (iv) nuchal plate covered by skin, (v) snout depressed, and (vi) maxillary barbel long, generally extending beyond gill opening (Reis 1998).

Despite the relatively large number of ichthyofaunistic surveys in Brazilian caves in the last 2 decades (e.g. Bichuette and Trajano 2003, Mattox et al. 2008, Trajano et al. 2009a, 2009b, Cordeiro et al. 2013, Secutti and Bichuette 2013), no Callichthyinae species have been captured or recorded so far. The first record of Callichthyinae



Figure 1. *Callichthys callichthys*, ZUFMS 5351, from the Casa do Caboclo cave, Sergipe state, Brazil, in dorsal, lateral and ventral views. Scale bar = 5 mm.

species in 3 different karst areas from Brazil is herein reported.

Methods

Specimens of *Callichthys callichthys* (Fig. 1) were collected by M. E. Bichuette in October 2014, in the Casa do Caboclo cave, Sergipe state, municipality of Japaratuba ($10^{\circ}37'57.2''$ S, $036^{\circ}52'59.1''$ W). A specimen of *Hoplosternum littorale* (Fig. 2) was captured by R. Brandi, on 10 September 2006, in the Gruna Lagoa do Meio cave, Bahia state, municipality of Coribe ($13^{\circ}45'23.7''$ S, $44^{\circ}13'47.3''$ W). Representatives of *Megalechis thoracata* (Fig. 3) were collected by G. M. V. Rosa, on 5

September 2015, in the Casa de Pedra cave, Tocantins state, municipality of Lagoa da Confusão ($10^{\circ}49'17.0''$ S, $049^{\circ}37'10.3''$ W). The specimens were fixed in 10% formalin, posteriorly transferred to 70% alcohol, and deposited at the Coleção de Ictiologia do Laboratório de Estudos Subterrâneos (LESCI), and Coleção Zoológica de Referência da Universidade Federal de Mato Grosso do Sul (ZUFMS) under the following voucher numbers: *Callichthys callichthys*: LESC 330, 5 specimens, and ZUFMS-PIS 5351, 5 specimens; *Hoplosternum littorale*: LESC 329, 1 specimen; *Megalechis thoracata*: LESC 331, 3 specimens. The map was produced with the software QGIS, version 1.7.4 (Fig. 4).



Figure 2. *Hoplosternum littorale*, LESCI 329, from the Gruna Lagoa do Meio cave, Bahia state, Brazil, in dorsal, lateral and ventral views. Scale bar = 5 mm.

Results

The identification of *C. callichthys*, *H. littorale* and *M. thoracata* followed Lehmann and Reis (2004), Reis (1997) and Reis et al. (2005), respectively. *Callichthys callichthys* was recognized by the following combination

of features: (i) strongly depressed head (vs moderately depressed in the remaining genera); (ii) infraorbital bones covered by thick layer of skin (Fig. 5a) (vs exposed in the remaining genera); (iii) scapulocoracoid covered by thick layer of skin in ventral view (vs exposed in the remaining genera); (iv) posterior portion of mesethmoid entirely



Figure 3. *Megalechis thoracata*, LESC 331, from the Casa de Pedra cave, Tocantins state, Brazil, in dorsal, lateral and ventral views. Scale bar = 5 mm.

covered by thick layer of skin (vs partially exposed in that portion in *C. fabricioi* Román-Valencia, Lehmann and Muñoz, 1999); and (V) smooth lower lip (vs serrated in *C. serralabium* Lehmann and Reis, 2004). *Hoplosternum littorale* was identified by the following combination of features: (i) infraorbital bones exposed (Fig. 5b) (vs covered by thick layer of skin in *Callichthys*); (ii) scapulocoracoid exposed in ventral view (vs covered by thick layer of skin in *Callichthys*); (iii) forked caudal fin (Fig.

2) (vs truncated in *Callichthys*, *Leptoplosternum* and *Megalechis*); (iv) infraorbital 1 articulated to the lateral ethmoid (Fig. 5b) (vs not articulated in *Dianema*); and (v) infraorbital 2 with extremely developed posterior laminar expansion, contacting compound pterotic (Fig. 5b) (vs conspicuously less developed, not contacting compound pterotic in *H. magdalena* Eigenmann, 1913 and *H. punctatum* Meek and Hildebrand, 1916). *Megalechis thoracata* was identified by the following combination

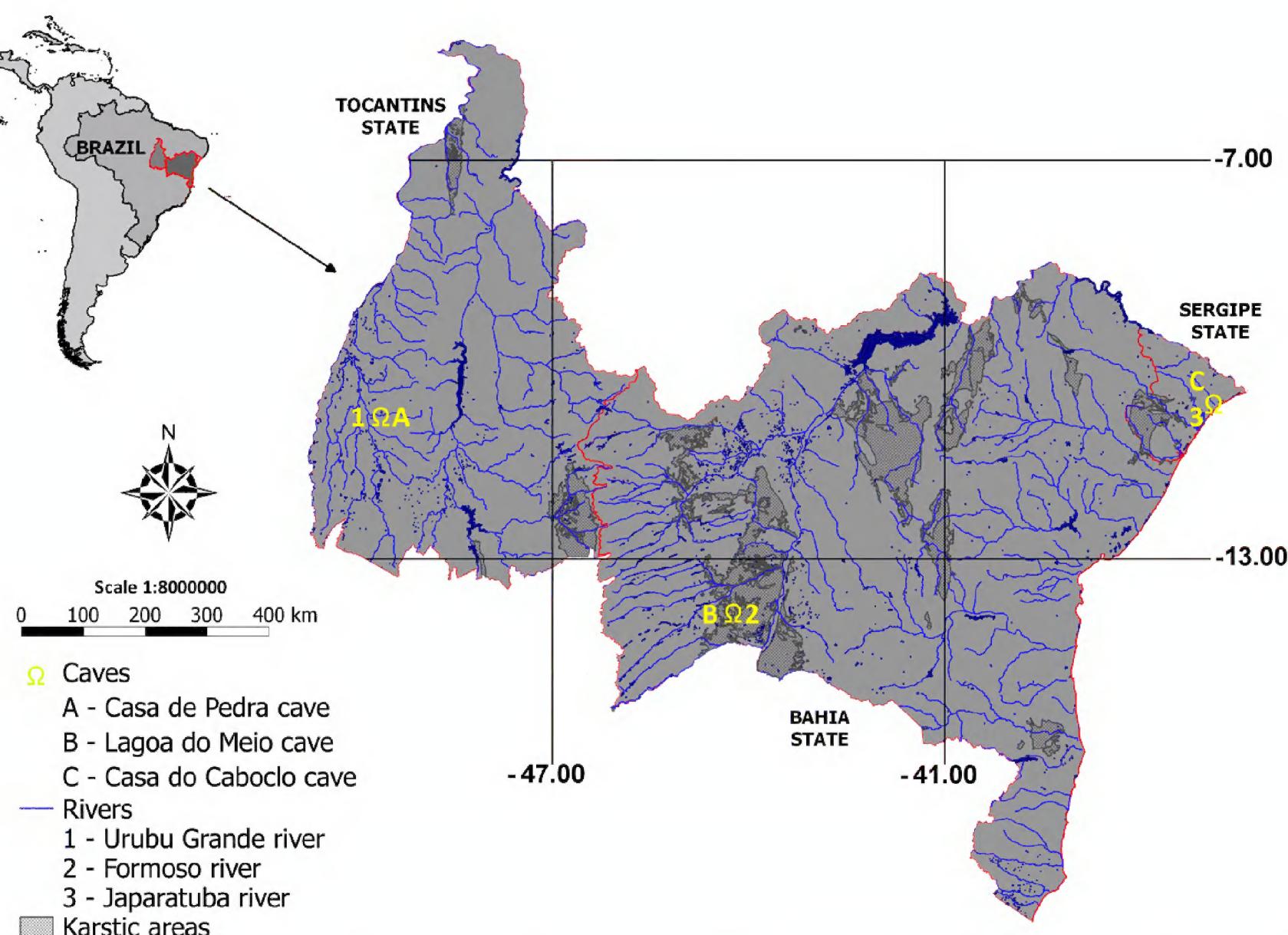
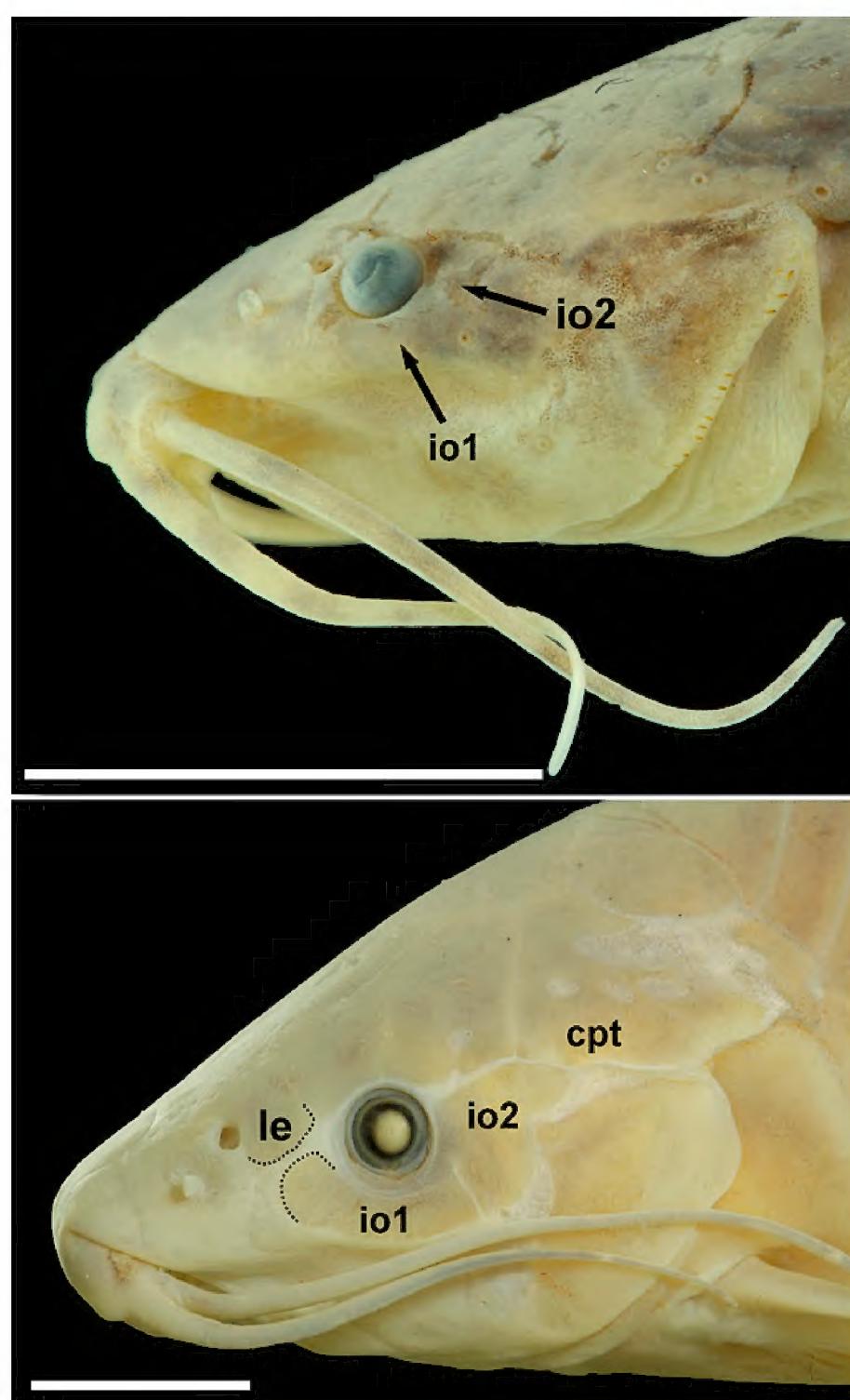


Figure 4. Map of the central and northeastern regions of Brazil showing the three new records: *Megalechis thoracata* (1ΩA), *Hoplosternum littorale* (BΩ2), and *Callichthys callichthys* (CΩ3).



of features: (i) infraorbital bones exposed (similar to the condition of *H. littorale* observed in Fig. 5b) (vs covered by thick layer of skin in *Callichthys*); (ii) scapulocoracoid exposed in ventral view (vs covered by thick layer of skin in *Callichthys*); (iii) truncated caudal fin (vs forked in *Hoplosternum* and *Dianema*); (iv) dorsal fin with one spine plus one simple ray, with remaining rays branched (Fig. 6) (vs one spine and remaining rays branched in *Leptoplosternum*); and (v) caudal fin with whitish proximal margin, remaining portion dusky or covered by black spots (Fig. 3) (vs proximal and distal margins of caudal-fin blackened, with a conspicuous transversal black bar in its middle portion, the regions between the blackened bands are clearly whitish yellow in *M. picta*). Although the three species presented clear reduction of pigmentation when compared to epigean specimens, no additional morphological differences were observed.

Discussion

Even in the extensive fieldworks focusing the ichthyofauna of Brazilian subterranean drainages, the record of

◀ **Figure 5.** Lateral view of the head: **A.** *Callichthys callichthys*, ZUFMS 5351, arrows indicating the position of the infraorbital 1 and 2, both covered by thick layer of skin. **B.** *Hoplosternum littorale*, LESC 329, showing the exposed infraorbitals 1 and 2; the articulation between lateral ethmoid and infraorbital 1 is indicated by a dotted line; and the contact between infraorbital 2 and compound pterotic. Abbreviations: io1 = infraorbital 1, io2 = infraorbital 2, le = lateral ethmoid, cpt = compound pterotic. Scale bar = 10 mm.

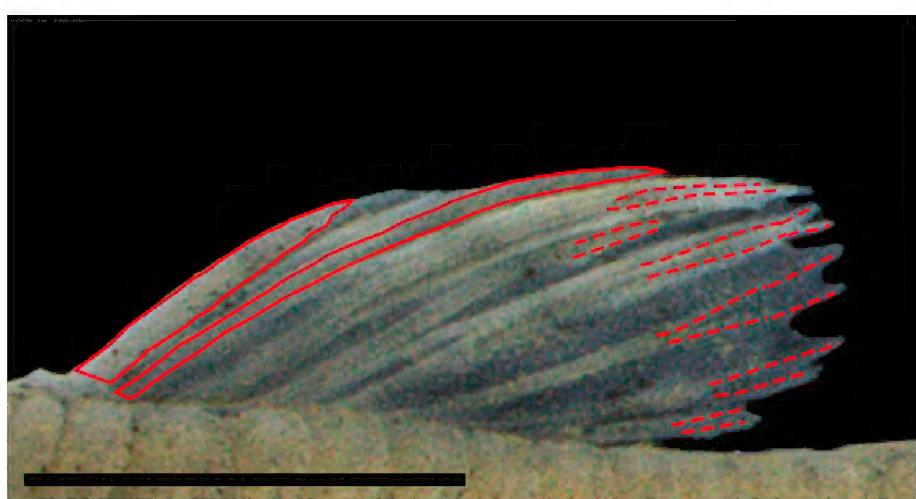


Figure 6. Dorsal fin of *Megalechis thoracata*, LESCI 331, showing the presence of one spine plus one simple ray, indicated by red line, and remaining branched rays bordered by a dashed red line. Scale bar = 5 mm.



Figure 7. Casa do Caboclo cave, showing the small river habitat where specimens of *Callichthys callichthys* were recorded.

Callichthyidae is quite uncommon (see Bichuette and Trajano 2003, Mattox et al. 2008, Trajano et al. 2009a, 2009b, Cordeiro et al. 2013, Secutti and Bichuette 2013). Recently, the first troglobitic Callichthyidae was described from a cave system in Central Brazil, *Aspidoras mephisto* Tencatt and Bichuette, 2017, and the fact that this species is the only species of Callichthyidae occurring in a cave system of about 6 km indicates that perhaps members of this family has some ecological and/or behavioral assumptions and maybe they cannot syntopically occur or are excluded in a competition for space and/or other resources in the subterranean drainages. The fact of each 1 of the 3 new records have been observed in distinctive caves, that is, without any sympatric distribution in the caves (Casa do Caboclo, Lagoa do Meio

and Casa de Pedra caves), reinforces this idea. Therefore, these records herein reported in caves are new to the subfamily Callichthinae and represent important information for conservation purposes.

Evaluating the new records of the 3 species, we are suggesting a cave ecological category for *Callichthys callichthys*, based on the high number of individuals representing different sizes and life stages (juveniles and adults) recorded in an isolated water body of Casa do Caboclo cave, formed by phreatic water. The occurrence of this species in other drainages reinforces this category, and the small hypogean drainage is likely an important shelter for this species in the region. Therefore, in this case, the aforementioned evidence suggests that *C. callichthys* can be considered as a troglophilic species, with populations capable of completing their life cycle inside and outside caves and other subterranean habitats and forming source populations both inside and outside hypogean habitats (sensu Trajano 2012). Notwithstanding, *Hoplosternum littorale* and *M. thoracata* are herein considered as accidental inhabitants in caves. Besides *H. littorale* being captured deeply inside, distant from the cave entrance (Lagoa do Meio) and in a hypogean drainage without connection with epigean ones, the record of only 1 specimen corroborates the idea that this species was probably visiting this habitat and that it may be considered an accidental occurrence. In the case of *M. thoracata*, even with 3 records, all individuals showed the same body length and were observed inside but close to the cave entrance in a river with connection to an epigean drainage, which indicates these individuals can be using the extension of the river occasionally or in a specific day phase. For this species, only a long term study focusing in population parameters can clarify this uncertainty.

The 3 Brazilian limestone caves where the new records were found are not under legal protection and present signs of degradation caused by anthropic activity. The Casa do Caboclo cave is formed by limestone of Sergipana Domain (Silva Filho et al. 1977) and is located in the Japaratuba river Basin, in the transition of Caatinga, interspersed by Rainforest and Coast influence. This is a small cave, ca 100 m of linear extension, with a water body on its distal part, probably formed by phreatic waters (Fig. 7). The surroundings of the cave are totally deforested, and agriculture and oil extraction are the main impacts. Additionally, the cave is used for religious purposes, which can also contribute to its degradation. The Gruna Lagoa do Meio cave is formed by limestone of the Bambuí Geomorphological Group (Auler et al. 2001) and is located in the Middle São Francisco river basin, in the Caatinga domain. The surroundings of the cave have no epigean drainage in the dry season, but, in the rainy season, some intermittent rivers are formed and crossed the cave. This cave has a large extension (> 1.0 km) with some stretches with stagnant air and high concentration of CO₂. The surrounding of this cave is well preserved, but agricultural activities in the neighborhood of the cave represent the main potential impact. The Casa de Pedra

cave is located in the limestone of the Bambuí Geomorphological Group (Auler et al. 2001) and is located in the Araguaia river basin (tributary to the Tocantins Basin), in the Cerrado domain. The main threat in the region is the extraction of limestone for cement production, besides agricultural activities.

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Authors' Contributions

LFCT, BFS and MEB wrote the manuscript, and took and edited the photographs; LFCT identified the species.

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